The Layers of the Atmosphere

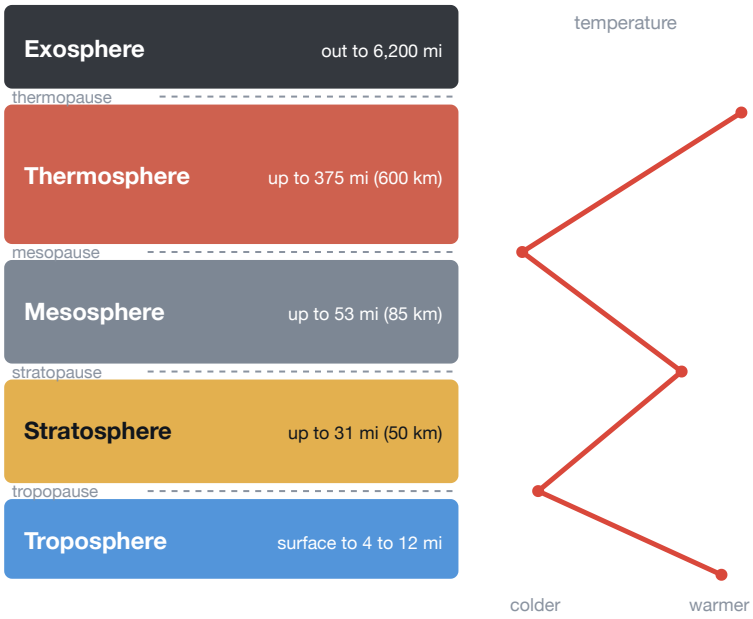
By the rock. August 8, 2026. Grounded in National Weather Service definitions.

The short version

The atmosphere is sorted into five layers by what the temperature does as you climb: troposphere, stratosphere, mesosphere, thermosphere, exosphere. Temperature falls, then rises, then falls, then rises again, and each reversal marks a boundary called a pause. Almost all weather happens in the troposphere, the thin bottom layer whose ceiling sits anywhere from just under four miles up at the poles to twelve miles up at the equator.

Five layers, sorted by temperature

The layers are not stacked by height so much as by behavior. NOAA identifies five distinct layers using thermal characteristics, chemical composition, movement, and density, and separates them with boundaries called pauses, where those characteristics change fastest. The shorthand that actually helps: every time the temperature stops doing one thing and starts doing the opposite, you have crossed into a new layer.



Not to scale, because nothing that spans six thousand miles fits on a phone. The red line is the point: temperature reverses four times on the way out, and each reversal is a boundary with a name.

The troposphere: the only layer that rains

Almost all weather occurs here. It starts at your feet, and its ceiling depends on where you are standing. NOAA gives three anchors: the troposphere is 11 to 12 miles (18 to 20 km) high at the equator, 5 and a half miles (9 km) at 50 degrees north and south, and just under four miles (6 km) high at the poles.

Temperature falls with height the whole way, from an average of about 62 F (17 C) near the surface to -60 F (-51 C) at the top. That falling temperature is what permits convection. Air warmed near the ground is less dense than the colder air sitting above it, so it can rise, and rising air is the engine behind every cloud, every shower, and every thunderstorm the rock has ever sat through.

The tropopause: the lid

At the top of the troposphere the cooling stops. Above that boundary the temperature starts increasing with height, which puts warmer air on top of cooler air, and that arrangement shuts vertical motion down. There is no upward push left to give.

You can see the lid with your own eyes. When a thunderstorm's updraft runs out of buoyancy near the tropopause, it spreads sideways instead of upward, and that spreading is the flat anvil top on a big storm. The sky is showing you exactly where one layer ends.

The stratosphere: warm on top, and 19 percent of the air

The stratosphere runs from the tropopause, somewhere between 4 and 12 miles (6 to 20 km) up depending on latitude, to around 31 miles (50 km). It holds 19 percent of the atmosphere's gases and very little water vapor. Its temperature climbs from that -60 F (-51 C) at the tropopause to a maximum of about 5 F (-15 C) at the top. The warming comes from the making of ozone: heat is produced in the process of ozone formation, and that heat is what raises the temperature with height. The boundary at the top is the stratopause.

The mesosphere: where meteors end

From around 31 miles (50 km) to 53 miles (85 km). Temperature falls again with height, or said the other way, it rises as you descend, reaching about 5 F (-15 C) near the bottom. The gases here are thin, but by now they are thick enough to slow a meteor until it burns, which is the fiery trail you see at night. The stratosphere and the mesosphere together are called the middle atmosphere, and the top of the mesosphere is the mesopause.

The thermosphere: hot without being warm

From about 53 miles (85 km) to 375 miles (600 km). Incoming high energy ultraviolet and X-ray radiation from the sun gets absorbed by molecules here, and the temperature climbs hard: from as low as -184 F (-120 C) at the bottom to as high as 3,600 F (2,000 C) near the top.

Which sounds lethal, and is not, at least not for that reason. Temperature describes how much energy the individual molecules are carrying. Up here there are so few molecules that the total heat they could hand you would not be enough to warm skin. It would feel bitterly cold. The rock offers this as proof that a number and a sensation are two different animals, which is the same lesson the dew point teaches at ground level.

The exosphere: the door

From about 375 miles (600 km) out to roughly 6,200 miles (10,000 km). Atoms and molecules escape into space from here, and satellites orbit through it. The transition layer at its bottom is the thermopause. Past the exosphere there is nothing left to sort.

What a forecaster actually uses

Mostly one boundary. The height of the tropopause sets the ceiling on how tall a storm can build, so a storm that reaches it and punches a bump slightly past it, an overshooting top, is a storm with a serious updraft underneath. The rest of the column is scenery. Excellent scenery. It simply does not rain.

Check your understanding

1. Which layer holds almost all of the weather?

- □ A. The stratosphere
- □ B. The troposphere
- □ C. The mesosphere

2. Why does a big thunderstorm spread out into a flat anvil instead of building higher?

- □ A. It runs out of water
- □ B. It reaches the tropopause, where temperature stops falling and rising air loses its push
- □ C. The jet stream flattens it from above

3. How high is the top of the troposphere?

- □ A. The same everywhere, about 7 miles
- □ B. From just under four miles at the poles to 11 or 12 miles at the equator
- □ C. Exactly 31 miles

4. The thermosphere can reach 3,600 F. What would it feel like to be there?

- □ A. Searing hot
- □ B. Bitterly cold
- □ C. About room temperature

5. What is a pause, in this context?

- □ A. A gap with no air in it
- □ B. A boundary between layers, where the thermal characteristics change fastest
- □ C. The moment a storm stops growing

Answer key

1. Which layer holds almost all of the weather?

B. The troposphere — The troposphere is the lower atmosphere, and almost all weather occurs in it. Its temperature falls with height, which is what lets air rise and build clouds.

2. Why does a big thunderstorm spread out into a flat anvil instead of building higher?

B. It reaches the tropopause, where temperature stops falling and rising air loses its push — Above the tropopause the temperature increases with height, putting warm air over cool. That kills vertical motion, so the updraft spreads sideways.

3. How high is the top of the troposphere?

B. From just under four miles at the poles to 11 or 12 miles at the equator — NOAA gives 11 to 12 miles at the equator, five and a half miles at 50 degrees north and south, and just under four miles at the poles.

4. The thermosphere can reach 3,600 F. What would it feel like to be there?

B. Bitterly cold — Temperature measures the energy of individual molecules, and up there the molecules are so scarce that the total heat delivered to your skin would be tiny. It would feel bitterly cold.

5. What is a pause, in this context?

B. A boundary between layers, where the thermal characteristics change fastest — Each layer is bounded by a pause: the tropopause, stratopause, mesopause, and thermopause, where the greatest changes in temperature, composition, movement, and density occur.

Questions people actually ask

Which layer are airplanes in?

Airliners cruise near the top of the troposphere and sometimes just into the lower stratosphere, which is a large part of why the ride is usually smooth up there: above the tropopause, the temperature rises with height and vertical motion is suppressed.

Why does the temperature go up in the stratosphere instead of down?

Because heat is produced in the process of ozone formation, and that heat warms the layer from within. NOAA gives the rise as -60 F (-51 C) at the tropopause to about 5 F (-15 C) at the top of the stratosphere.

Where does the atmosphere actually end?

It thins out rather than stopping. The outermost layer is the exosphere, which NOAA places from about 375 miles (600 km) to 6,200 miles (10,000 km) up, and it is where atoms and molecules escape into space.

Why is the troposphere taller at the equator?

The tropopause height follows how deeply the atmosphere is being stirred and warmed from below, and that reaches highest over the tropics. NOAA gives 11 to 12 miles at the equator against just under four miles at the poles.

Does weather ever happen above the troposphere?

Almost none of what you would call weather. The strongest thunderstorms nudge a small overshooting top a short way into the stratosphere, and noctilucent clouds form near the top of the mesosphere, but rain, snow, and wind you can feel are troposphere business.

Do weather balloons make it out of the troposphere?

Routinely. Radiosonde balloons profile temperature, moisture, and wind all the way up through the troposphere and keep climbing well into the stratosphere before they burst. Those twice daily climbs are a large part of how forecast models know what the upper air is doing.
